UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/653,791	09/02/2003	Akio Ohba	81617 [SC-70003US]	6922

22242 7590 11/21/2006

FITCH EVEN TABIN AND FLANNERY
120 SOUTH LA SALLE STREET
SUITE 1600
CHICAGO, IL 60603-3406

EXAMINER	
REPKO, JASON MICHAEL	

ART UNIT	PAPER NUMBER
2628	

DATE MAILED: 11/21/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/653,791	OHBA, AKIO	
	Examiner	Art Unit	
	Jason M. Repko	2628	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☐ Responsive to communication(s) filed on _____.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-7,9-29 and 31-34* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-7,9-29 and 31-34* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *12/29/2005* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Claim Rejections - 35 USC § 112

1. The rejections presented in the Office Action dated 30 May 2006 under 35 USC § 112 with respect to claim 22 have been withdrawn.

2. The following is a quotation of the first paragraph of 35 U.S.C. 112:

> The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

3. **Claims 1-7, 9-18, 25-29, and 31-34 are rejected under 35 U.S.C. 112, first paragraph, because the specification, while being enabling for software units, does not reasonably provide enablement for hardware units.** The specification does not enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make the invention commensurate in scope with these claims. In lines 18-22, page 27 of the descriptive portion of the specification, the units are disclosed as being hardware or software or both: "The figure is a block diagram focusing attention on functions and the functions identified in the function blocks can be realized in various ways such as using only hardware or only software, or a combination of both." However, the specification does not enable one of ordinary skill in the art to make a grouping unit, rendering processing unit, and consolidation unit in hardware.

Claim Rejections - 35 USC § 101

4. 35 U.S.C. 101 reads as follows:

> Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title.

5. **Claims 21-24 are rejected under 35 U.S.C. 101 because the claimed invention is directed to non-statutory subject matter.**

6. Claims 21-24 are directed to a "storage medium," where the storage medium is not disclosed as being "computer-readable." In contrast, a claimed computer-readable medium storing a computer program is a computer element which defines structural and function interrelationships between the computer program and the rest of the computer which permit the computer program's functionality to be realized, and is thus statutory. Therefore, claims 21-24 are directed to nonstatutory functional descriptive material. Additionally, claims 21-24 do not exclude carrier waves, or signals encoded with computer program instructions, which are nothing but the physical characteristics of a form of energy, and as such, claims 21-24 do not exclude nonstatutory natural phenomena.

7. To expedite a complete examination of the instant application, the claims rejected under 35 U.S.C. 101 as non-statutory subject matter are further rejected as set forth below in anticipation of applicant amending the claims to place them within the four categories of invention.

Claim Rejections - 35 USC § 103

8. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

9. The factual inquiries set forth in *Graham* v. *John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.

2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

10. Claims 1-6 and 20-27 are rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent Application Pub. No. 2002/0015055 to Foran in view of U.S. Patent No. 6,016,150 to Lengyel et al.

11. With regard to claim 1, Foran discloses "an image processing apparatus comprising:

a. a rendering processing unit which derives a three-dimensional subspace which contains the three-dimensional objects belonging to the same group to be an independent rendering unit (*paragraph [0040]: "First, the dimensions of the scene are bounded by a rectangular volume as shown in FIG. 2. Next, this volume is decomposed into rectangular subvolumes as shown in FIG. 3 such that each subvolume includes a portion of the overall scene...The position of each vertex is compared with the positions of the planar sides of the subvolumes to determine the subvolume to which the graphics primitive should be assigned."*), and generates independent image data for each subspace (*paragraph [0044]: "In FIG. 5, at a step 506, the viewing position is communicated to each GPU. At a step 508, each GPU renders the graphics data that has been allocated to it."*); and

b. a consolidation unit which generates final output image data to be displayed by consolidating the image data generated for each subspace (*paragraph [0045]: "At a step 512, the outputs of the individuals GPUs are combined by blending."; Figure 7*),

c. wherein the grouping unit groups three-dimensional objects into groups in such a manner that the three-dimensional subspaces, each of which contains at least one three-

dimensional object belonging to the same group, are allowed to spatially overlap one another (*paragraph [0040]: "Where vertices of a graphics primitive indicate that it spans a boundary between subvolumes, the graphics primitive will be assigned to each subvolume."*).

12. Foran does not use the language allowing subspaces to spatially overlap; however, one of ordinary skill in the art would recognize that this feature is present as Foran discloses in paragraph [0040] that primitives that "span the boundary between subvolumes are assigned to each subvolume" and "Where parts of a graphics primitive exceed the boundaries of a subvolume, the GPU will clip that graphics primitive to the boundaries of the subvolume." Since a primitive can be assigned more than one subspace and primitives assigned to a subspace exceed the boundaries of the subvolume, while Foran does not expressly disclose the subvolumes overlap, the subspaces, the "portion of the overall scene" assigned to each rendering unit, must spatially overlap.

13. Foran does not expressly disclose "a grouping unit which selects rendering strategy according to characteristics of input three-dimensional objects and groups the three-dimensional objects into groups in such a manner that the three-dimensional objects to which the same rendering strategy is applied are grouped into the same group;" or "performing rendering processing individually on the subspace by applying the group by group different rendering strategy."

14. Lengyel et al discloses "a grouping unit which selects rendering strategy according to characteristics of input three-dimensional objects (*lines 4-7 of column 10: "Preferably, the scene should be factored to identify scene elements (or sets of scene elements) that can be rendered to*

separate layers at different update rates and spatial resolution."; lines 33-38 of column 10 (emphasis added): "Geometry factoring should consider the following properties of objects and their motions: 1. Relative velocity 2. Perceptual distinctness 3. Ratio of clear to "touched" pixels.") and groups the three-dimensional objects into groups in such a manner that the three-dimensional objects to which the same rendering strategy is applied are grouped into the same group (*line 66 of column 10 through line 2 of column 11: "Background elements should be blurred by using a lower sampling rate. The main actor requires more samples in space and time. In order to make such tradeoffs, perceptually distinct objects must be separated into layers."*);" or "performing rendering processing individually on the subspace by applying the group by group different rendering strategy" (*lines 15-17 of column 6: "In a layered pipeline, the spatial resolution of each of the layers can differ from each other and from the resolution of the output image."; lines 24-25 of column 6: "The temporal resolution of each of the layers can also vary from one another and from the display update rate."*).

15. At the time of the invention, it would have been obvious to a person of ordinary skill in the art to incorporate a grouping unit and a group by group different rendering strategy disclosed by Lengyel et al in the system disclose by Foran. The motivation for doing so would have been to improve computation efficiency and the appearance of the resulting displayed image, as suggested by Lengyel et al in line 66 of column 10 through line 2 of column 11. Therefore, it would have been obvious to combine Lengyel et al with Foran to obtain the invention specified in claim 1.

16. With regard to claim 2, Lengyel et al discloses a viewing frustum (*lines 9-12 of column 22: "As described above, the preprocessor clips characteristic bounding polyhedron to a viewing*

frustum that extends beyond the screen boundary (the expanded sprite extent).") and a coordinate transform unit and rendering unit (*lines 25-27 of column 12: "The renderer 100 independently renders the fully illuminated layer by rendering a fully illuminated scene from the perspective of the viewpoint.*") for transforming the three-dimensional object to screen space and rendering the image (*lines 12-16 of column 15: "When creating a sprite image, we must consider a new transform in the standard pipeline in addition to the modeling, viewing, and projection transforms: a 2D transformation that transforms samples in sprite coordinates to screen coordinates."; lines 25-28 of column 15: "FIG. 8 is a diagram illustrating an example of mapping an object 120 from modeling coordinates 121 to sprite coordinates 122, and then mapping the object 120 from sprite coordinates to the screen coordinates 123.*").

17. The combination of Foran and Lengyel et al does not explicitly disclose "a quadrangular truncated pyramid." Official Notice is taken that both the concept and the advantages of providing quadrangular truncated pyramid for perspective transformation and rendering of three-dimensional objects are well known and expected in the art. It would have been obvious to have included a quadrangular truncated pyramid in Lengyel et al as quadrangular truncated pyramids are known to provide a boundary for the viewable space of a virtual scene that is analogous to the visible volume of space in real-world image formation processes. Therefore, it would have been obvious to one of ordinary skill in the art to obtain the invention recited in claim 2.

18. Claim 3 is met by the combination of Foran and Lengyel et al, wherein Lengyel et al discloses "the grouping unit, based on motion characteristics of the three-dimensional objects (*lines 33-38 of column 10 (emphasis added): "Geometry factoring should consider the following properties of objects and their <u>motions</u>...*"), selects the rendering strategy on whether motion

blurring processing is applied or not, and groups the three-dimensional objects to which the motion blurring processing is applied, into the same group" (*lines 26-31 of column 16 (emphasis added): "For a linear motion blur effect, the sprite sampling along one of the axes may be reduced to blur along that axis. The sprite rendering transformation should align one of the coordinate axes to the object's velocity vector by setting the bounding slab directions to the velocity vector and its perpendicular."*).

19. Claim 4 recites limitations similar in scope to those of claim 3. Claim 4 is rejected with the rational of claim 3.

20. Claim 5 is met by the combination of Foran and Lengyel et al, wherein Lengyel et al discloses "the grouping unit, based on information related to level of detail in rendering the three-dimensional objections, selects the rendering strategy in which multi-resolution rendering is applied at a resolution depending on the level of detail, and groups the three-dimensional objects to be rendered at the same resolution into the same group" (*line 66 of column 10 through line 2 of column 11: "Background elements should be blurred by using a lower sampling rate. The main actor requires more samples in space and time. In order to make such tradeoffs, perceptually distinct objects must be separated into layers."; lines 54-57 of column 10: "Second, layered rendering more optimally targets rendering resources. Less important layers can be rendered at a lower spatial and temporal resolution to conserve resources for important layers."*).

21. Claim 6 recites limitations similar in scope to those of claim 5. Claim 6 is rejected with the rational of claim 5.

22. With regard to claim 20, Foran discloses "an image processing method comprising grouping a plurality of three-dimensional objects into groups" (*paragraph [0040]: "First, the dimensions of the scene are bounded by a rectangular volume as shown in FIG. 2. Next, this volume is decomposed into rectangular subvolumes as shown in FIG. 3 such that each subvolume includes a portion of the overall scene... The position of each vertex is compared with the positions of the planar sides of the subvolumes to determine the subvolume to which the graphics primitive should be assigned."*) "performing rendering processing individually on a subspace which contains at least on three dimensional object belonging to the same group" (*paragraph [0044]: "In FIG. 5, at a step 506, the viewing position is communicated to each GPU. At a step 508, each GPU renders the graphics data that has been allocated to it."*) and generating final image data to be displayed by consolidating rendering data of each subspace (*paragraph [0045]: "At a step 512, the outputs of the individuals GPUs are combined by blending."; Figure 7*), wherein three-dimensional subspace, each of which contains at least one three-dimensional object belonging to the same group, are allowed to spatially overlap one another (*paragraph [0040]: "Where vertices of a graphics primitive indicate that it spans a boundary between subvolumes, the graphics primitive will be assigned to each subvolume."*)

23. With regard to claim 20, Foran does not disclose grouping "in such a manner that the three-dimensional objects to which same rendering strategy is applied are grouped into the same group and "applying the group by group different rendering strategy."

24. With regard to claim 20, Lengyel et al discloses "grouping the three-dimensional objects which exist in a display area into groups in such a manner that the three dimensional objects to which the same rendering strategy is applied are grouped into the same group (*lines 33-38 of*

column 10: "Geometry factoring should consider the following properties of objects and their motions: 1. Relative velocity 2. Perceptual distinctness 3. Ratio of clear to "touched" pixels."; line 66 of column 10 through line 2 of column 11); performing rendering processing individually by subspace unit by applying the group by group different rendering strategy to generate image data for each subspace (*lines 15-17 of column 6*; *lines 24-25 of column 6; lines 7-12 of column 6*).

25. With regard to claim 21, Foran discloses "a storage medium storing a computer program executable by a computer (*paragraph [0040]: "In an embodiment where the invention is implemented using software, the software may be stored in a computer program product and loaded into computer system 800 using removable storage drive 814, hard drive 812 or communications interface 824."*), the program comprising:

d. deriving a subspace which contains the three-dimensional objects belonging to the same group to be an independent rendering unit (*paragraph [0040]: "First, the dimensions of the scene are bounded by a rectangular volume as shown in FIG. 2. Next, this volume is decomposed into rectangular subvolumes as shown in FIG. 3 such that each subvolume includes a portion of the overall scene…The position of each vertex is compared with the positions of the planar sides of the subvolumes to determine the subvolume to which the graphics primitive should be assigned."; paragraph [0044]: "In FIG. 5, at a step 506, the viewing position is communicated to each GPU. At a step 508, each GPU renders the graphics data that has been allocated to it."*); and

e. generating final image data to be displayed in the display area by consolidating the image data generated for each subspace (*paragraph [0045]: "At a step 512, the outputs of the individuals GPUs are combined by blending."; Figure 7*)

f. wherein the grouping groups three-dimensional objects into groups in such a manner that the three-dimensional subspaces, each of which contains at least one three-dimensional object belonging to the same group, are allowed to spatially overlap one another (*paragraph [0040]: "Where vertices of a graphics primitive indicate that it spans a boundary between subvolumes, the graphics primitive will be assigned to each subvolume."*).

26. Foran does not disclose "group by group different rendering strategy." Lengyel et al discloses "selecting a rendering strategy according to characteristics of the three-dimensional objects" (*lines 4-7 of column 10: "Preferably, the scene should be factored to identify scene elements (or sets of scene elements) that can be rendered to separate layers at different update rates and spatial resolution."*); "grouping the three-dimensional objects which exist in a display area into groups in such a manner that the three dimensional objects to which the same rendering strategy is applied are grouped into the same group (*lines 33-38 of column 10: "Geometry factoring should consider the following properties of objects and their motions: 1. Relative velocity 2. Perceptual distinctness 3. Ratio of clear to "touched" pixels."; line 66 of column 10 through line 2 of column 11*); performing rendering processing individually by subspace unit by applying the group by group different rendering strategy to generate image data for each subspace (*lines 15-17 of column 6*; *lines 24-25 of column 6; lines 7-12 of column 6*).

27. With regard to claims 20 and 21, at the time of the invention, it would have been obvious to a person of ordinary skill in the art to incorporate a grouping unit and a group by group different rendering strategy disclosed by Lengyel et al in the system disclose by Foran. The motivation for doing so would have been to improve computation efficiency and the appearance of the resulting displayed image, as suggested by Lengyel et al in line 66 of column 10 through line 2 of column 11. Therefore, it would have been obvious to combine Lengyel et al with Foran to obtain the invention specified in claims 20 and 21.

28. The combination of Foran and Lengyel et al does not expressly disclose "reading array data of a plurality of three-dimensional objects." Official Notice is taken that both the concept and the advantages of providing an array for reading three-dimensional objects of a scene are well known and expected in the art. It would have been obvious to have included the operation of reading array data in the system disclosed by the combination of Foran and Lengyel et al as arrays are known to provide a random access data retrieval and a simple implementation. Therefore, it would have been obvious to one of ordinary skill in the art to obtain the invention recited in claim 21.

29. With regard to claim 22, the combination of Foran and Lengyel et al discloses the limitations of parent claim 21. Lengyel et al further discloses "calculating a position of each of the three-dimension objects in a viewpoint coordinate system" (*line 65 of column 6 through line 3 of column 7: "In FIG. 2, the input 32 to a layered pipeline includes the set of 3D objects in the scene, and the position of objects, light sources, and the viewpoint for the scene. In the context of animation, the position of objects, light sources and the viewpoint can be time-varying, in which case, the position of these scene elements are represented as functions of time."*) "and

determining information related to level of detail in rendering each of the three-dimensional objects based on a distance from the viewpoint, and wherein said grouping groups the three-dimensional objects which exist in the display area into the groups according to the information related to level of detail (*line 66 of column 10 through line 2 of column 11: "Background elements should be blurred by using a lower sampling rate. The main actor requires more samples in space and time. In order to make such tradeoffs, perceptually distinct objects must be separated into layers."; lines 54-57 of column 10: "Second, layered rendering more optimally targets rendering resources. Less important layers can be rendered at a lower spatial and temporal resolution to conserve resources for important layers."*).

30. Claim 23 and 24 is met by the combination of Foran and Lengyel et al, wherein Foran discloses "the rendering processing are performed in such a manner that the rendering processing for each subspace is distributed to a plurality of rendering processing units" (*paragraph [0044]: "In FIG. 5, at a step 506, the viewing position is communicated to each GPU. At a step 508, each GPU renders the graphics data that has been allocated to it."; 701-724 shown in Figure 7*).

31. Claim 25 is met by the combination of Foran and Lengyel et al, wherein Lengyel et al discloses "the rendering strategy is a rendering algorithm applied to the three-dimensional objects" (*lines 2-6 of column 6: "FIG. 2 is a diagram depicting a layered graphics rendering pipeline 30. Like a traditional frame buffer approach, the input to the pipeline is a 3D scene 32 describing the position and visual attributes of the graphical objects in the scene."*).

32. Claim 26 is met by the combination of Foran and Lengyel et al, wherein Lengyel et al discloses "the rendering algorithm is a hidden surface removal algorithm" (*lines 43-45 of column 29 (emphasis added): "The tiler 236 performs scan-conversion, shading, texturing, hidden-*

surface removal, anti-aliasing, translucency, shadowing, and blending for multi-pass rendering.").

33. Claim 27 is met by the combination of Foran and Lengyel et al, wherein Lengyel et al discloses "wherein the rendering algorithm is a shading algorithm" (*lines 43-45 of column 29 (emphasis added): "The tiler 236 performs scan-conversion, shading, texturing, hidden-surface removal, anti-aliasing, translucency, shadowing, and blending for multi-pass rendering."*)

34. **Claims 9-14, 17, and 18 are rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent Application Pub. No. 2002/0015055 to Foran in view of U.S. Patent No. 6,016,150 to Lengyel et al in view of Kwan Liu Ma, James S. Painter, Charles D. Hansen, Michael F. Krogh, "A Data Distributed, Parallel Algorithm for Ray-Traced Volume Rendering," October 25, 1993, Proceedings of the 1993 Symposium on Parallel Rendering, p. 15-22 (Ma et al).**

35. With regard to claims 9 and 10, the combination of Foran and Lengyel et al shows the limitations of the parent claim 1, but does not disclose assigning to rendering units based on performance and complexity. Ma et al teaches "the rendering processing unit comprises a plurality of rendering units (*first paragraph of section 4: "Currently, the data distributor runs as a single 'host' process that determines the partitions of the data set, reads the data set piece by piece from disk and distributes it to a set of 'node' processes that perform the actual rendering and compositing.*") and distributes the rendering processing to the plurality of the rendering units according to complexity level of the rendering processing by subspace unit" (*third paragraph of section 6: "The data subdivision can be done unevenly, taking into account the predicted capacity on each machine to try to balance the load."*).

36. With regard to claims 11 and 12, the combination of Foran and Lengyel et al shows the limitations of parent claim 1, but does not disclose assigning to rendering units based on performance and complexity. Ma et al teaches "the rendering processing unit comprises a plurality of rendering units (*shown in the rejection of claims 9 and 10*) with different processing performance and assigns the rendering processing to the plurality of the rendering units, each of which has the appropriate processing performance corresponding to complexity level of the rendering processing by subspace unit" (*third paragraph of section 6: "Alternatively, the data can be subdivided into larger number of equal sized subvolumes and the more capable machines can be assigned more than one subvolume."*).

37. With regard to claims 13 and 14, the combination of Foran and Lengyel et al shows the limitations of parent claim 1, but does not disclose external networks. Ma et al teaches "a communication unit which receives image data rendered by subspace unit from an external distributed rendering processing device connected with the apparatus via a network" (*first paragraph of section 3.3: "Each computer can perform ray tracing independently; that is, there is no data communication required during the sub volume rendering."; fourth paragraph of section 3.4: "In our example, as shown in (b), Computer 1 keeps only the left half-image and sends its right half-image to its immediate right sibling, which is Computer 2."*), and "wherein the consolidation unit consolidates the image data received from the external distributed rendering processing device with the image data generated by the rendering processing unit and generates the final output image data to be displayed" (*first paragraph of section 3.4: "The final step of our algorithm is to merge ray segments and thus all partial images into the final total image."*).

38. With regard to claims 17 and 18, Foran discloses "an image processing apparatus comprising:

g. a rendering processing unit which derives a three-dimensional subspace which contains the three-dimensional objects belonging to the same group to be an independent rendering unit (*paragraph [0040]: "First, the dimensions of the scene are bounded by a rectangular volume as shown in FIG. 2. Next, this volume is decomposed into rectangular subvolumes as shown in FIG. 3 such that each subvolume includes a portion of the overall scene...The position of each vertex is compared with the positions of the planar sides of the subvolumes to determine the subvolume to which the graphics primitive should be assigned."*), and generates independent image data for each subspace (*paragraph [0044]: "In FIG. 5, at a step 506, the viewing position is communicated to each GPU. At a step 508, each GPU renders the graphics data that has been allocated to it."*); and

h. a consolidation unit which generates final output image data to be displayed by consolidating the image data generated for each subspace (*paragraph [0045]: "At a step 512, the outputs of the individuals GPUs are combined by blending."; Figure 7*),

i. wherein the grouping unit groups three-dimensional objects into groups in such a manner that the three-dimensional subspaces, each of which contains at least one three-dimensional object belonging to the same group, are allowed to spatially overlap one another (*paragraph [0040]: "Where vertices of a graphics primitive indicate that it spans a boundary between subvolumes, the graphics primitive will be assigned to each subvolume."*).

39. With regard to claims 17 and 18, Foran does not use the language allowing subspaces to spatially overlap; however, one of ordinary skill in the art would recognize that this feature is present as Foran discloses in paragraph [0040] that primitives that "span the boundary between subvolumes are assigned to each subvolume" and "Where parts of a graphics primitive exceed the boundaries of a subvolume, the GPU will clip that graphics primitive to the boundaries of the subvolume." Since a primitive can be assigned more than one subspace and primitives assigned to a subspace exceed the boundaries of the subvolume, while Foran does not expressly disclose the subvolumes overlap, the subspaces, the "portion of the overall scene" assigned to each rendering unit, must spatially overlap.

40. With regard to claims 17 and 18, Foran does not expressly disclose "a grouping unit which selects rendering strategy according to characteristics of input three-dimensional objects and groups the three-dimensional objects into groups in such a manner that the three-dimensional objects to which the same rendering strategy is applied are grouped into the same group;" or "performing rendering processing individually on the subspace by applying the group by group different rendering strategy."

41. With regard to claims 17 and 18, Lengyel et al discloses "a grouping unit which selects rendering strategy according to characteristics of input three-dimensional objects (*lines 4-7 of column 10: "Preferably, the scene should be factored to identify scene elements (or sets of scene elements) that can be rendered to separate layers at different update rates and spatial resolution."; lines 33-38 of column 10 (emphasis added): "Geometry factoring should consider the following <u>properties of objects and their motions</u>: 1. Relative velocity 2. Perceptual distinctness 3. Ratio of clear to "touched" pixels."*) and groups the three-dimensional objects

into groups in such a manner that the three-dimensional objects to which the same rendering strategy is applied are grouped into the same group (*line 66 of column 10 through line 2 of column 11: "Background elements should be blurred by using a lower sampling rate. The main actor requires more samples in space and time. In order to make such tradeoffs, perceptually distinct objects must be separated into layers."*);" and "performing rendering processing individually on the subspace by applying the group by group different rendering strategy" (*lines 15-17 of column 6: "In a layered pipeline, the spatial resolution of each of the layers can differ from each other and from the resolution of the output image."; lines 24-25 of column 6: "The temporal resolution of each of the layers can also vary from one another and from the display update rate."*).

42. At the time of the invention, it would have been obvious to a person of ordinary skill in the art to incorporate a grouping unit and a group by group different rendering strategy disclosed by Lengyel et al in the system disclose by Foran. The motivation for doing so would have been to improve computation efficiency and the appearance of the resulting displayed image, as suggested by Lengyel et al in line 66 of column 10 through line 2 of column 11.

43. With regard to claims 17 and 18, Foran and Lengyel et al does not disclose a distributed system. Ma et al teaches "plurality of image processing apparatus for exchanging information with each other via a network and performing distributed rendering processing," as recited in claim 17, and "wherein a processing result by the function block which is not included in this apparatus is received from the other apparatus and utilized," as recited in claim 18 (*fourth paragraph of section 3.4: "In our example, as shown in (b), Computer 1 keeps only the left half-image and sends its right half-image to its immediate right sibling, which is Computer 2."; first*

paragraph of section 4.2: "Thus, using a set of high performance work stations connected by an Ethernet, our goal is to set up a volume rendering facility..."). Furthermore, Ma et al teaches that grouping, the rendering processing and the consolidation are functionally distributed among the plurality of the image processing apparatus (*first paragraph of section 3.3: "Each computer can perform ray tracing independently; that is, there is no data communication required during the sub volume rendering."; first paragraph of section 4: "Currently, the data distributor runs as a single 'host' process that determines the partitions of the data set, reads the data set piece by piece from disk and distributes it to a set of 'node' processes that perform the actual rendering and compositing.*").

44. With regard to claims 9-14, 17, and 18, at the time of the invention, it would have been obvious to a person of ordinary skill in the art to distribute the grouping unit, rendering processing unit, and consolidation unit disclosed by Lengyel et al across a plurality of image processing apparatuses as taught by Ma et al. The motivation for doing so would have been to accelerate rendering as stated by Ma et al in the first paragraph of section 1. Therefore, it would have been obvious to further modify the combination of Foran and Lengyel et al with Ma et al to obtain the invention specified in claims 9-14, 17, and 18.

45. Claims 15 and 16 are rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent Application Pub. No. 2002/0015055 to Foran in view of U.S. Patent No. 6,016,150 to Lengyel et al in view of Kwan Liu Ma, James S. Painter, Charles D. Hansen, Michael F. Krogh, "A Data Distributed, Parallel Algorithm for Ray-Traced Volume Rendering," October 25, 1993, Proceedings of the 1993 Symposium on Parallel Rendering, p. 15-22 (Ma et al) and in further view of Jerrell Watts, Stephen Taylor, "A Practical

Approach to Dynamic Load Balancing," March 1998, IEEE Transactions on Parallel and Distributed Systems, v. 9 n. 3, p. 235-248 (Watts et al).

46. With regard to claims 15 and 16, the combination of Foran, Lengyel et al and Ma et al shows the limitations of parent claims 13 and 14, but does not show rendering processing load assigned corresponding to network distance. Watts et al teaches a task is assigned to a plurality of the distributed devices, each of which has different network distance corresponding a task's transfer cost (*fourth paragraph of section 5.2: "In the first case, a task's transfer cost was taken to be the change in the distance from the actual location of its data structures to its proposed new location: i.e. the transfer for task i was...where dist is a function which gives the network distance between any two computers..."*). One of ordinary skill in the art would recognize that the level of detail is directly related to the amount of data and the transfer cost of the object to be rendered from the statement by Ma et al in the second paragraph of section 6: "For example, a processor tracing through empty space will probably finish before another processor working on a dense section of the data."

47. At the time of the invention, it would have been obvious to a person of ordinary skill in the art to use the network distance based load balancing method taught by Watts et al to distribute the rendering tasks disclosed by the Lengyel et al and Ma et al system according to transfer cost. Ma et al suggests in the third paragraph of section 6, "Performance of the distributed workstation implementation could be further improved by better load balancing"; thus, the motivation for doing so would have been to improve the performance of the rendering system. Therefore, it would have been obvious to modify the Lengyel et al and Ma et al combination with Watts et al to obtain the invention specified in claims 15 and 16.

48. **Claims 28 and 29 are rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent Application Pub. No. 2002/0015055 to Foran in view of U.S. Patent No. 6,016,150 to Lengyel et al in view of U.S. Patent No. 5,986,659 to Gallery et al.**

49. With regard to claims 28 and 29, Lengyel et al discloses "the grouping unit, based on information related to level of detail in rendering the three dimensional objects, selects the rendering strategy which defocus processing is applied, and groups the three-dimensional objects to which the defocus processing is applied" (*line 66 of column 10 through line 2 of column 11: "Background elements should be blurred by using a lower sampling rate. The main actor requires more samples in space and time. In order to make such tradeoffs, perceptually distinct objects must be separated into layers."*). Lengyel et al does not disclose a "focus depth depending on the level of detail." Gallery et al discloses a "defocus processing is applied at a focus depth depending on the level of detail" (*lines 10-16 of column 3: "Specifying a point of focus P (a depth value at the place in the image that the observer is looking at), in order to give the appearance of focus/de-focus it is assumed that for pixels in the image with depth close to that of the point of focus the image should be sharp, but, as the depth of a pixel gets further away from the depth of the point of focus.(whether nearer or closer to the position of the observer) then the image should become more blurred."*).

50. At the time of the invention, it would have been obvious to a person of ordinary skill in the art to perform defocus processing at a focus depth as taught by Gallery et al in the system and method disclosed by the combination of Foran and Lengyel et al. The motivation for doing so would have been to model the process of image formation of a physical camera, thereby improving the realism of the resulting images as suggested by Gallery et al "Synthetically

generated computer graphics images normally suffer from the deficiency of being uniformly sharp, i.e. all parts of the image appear to be in focus" (lines 10-12 of column 1). Therefore, it would have been obvious to combine Gallery et al with Foran and Lengyel et al to obtain the invention specified in claim 28 and 29.

51. **Claims 19 and 33 rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent Application Pub. No. 2002/0015055 to Foran in view of U.S. Patent No. 5,867,166 to Myhrvold et al.**

52. With regard to claim 19, Foran discloses "an image processing method comprising dividing a space into three-dimensional subspaces which are allowed to spatially overlap one another (*paragraph [0040]: "First, the dimensions of the scene are bounded by a rectangular volume as shown in FIG. 2. Next, this volume is decomposed into rectangular subvolumes as shown in FIG. 3 such that each subvolume includes a portion of the overall scene...The position of each vertex is compared with the positions of the planar sides of the subvolumes to determine the subvolume to which the graphics primitive should be assigned."; paragraph [0040]: "Where vertices of a graphics primitive indicate that it spans a boundary between subvolumes, the graphics primitive will be assigned to each subvolume."*) and performing rendering processing independently by subspace unit on at least one three-dimensional object in each of the subspaces (*paragraph [0044]: "In FIG. 5, at a step 506, the viewing position is communicated to each GPU. At a step 508, each GPU renders the graphics data that has been allocated to it."*), and consolidating the rendering data of at least one three-dimensional object in each of the subspaces" (*paragraph [0045]: "At a step 512, the outputs of the individuals GPUs are combined by blending."; Figure 7*).

53. Foran discloses, "image blending accounts for the spatial relationships between the viewing position and the rendered images so that objects that are more near the viewing position overwrite those that are more distant" (*paragraph [0045]*). Foran does not expressly disclose "generating rendering data having depth information on a pixel by pixel basis" and "evaluating a distance in depth direction on a pixel by pixel basis."

54. With regard to claim 19, Myhrvold et al discloses "an image processing method comprising dividing a space into subspaces (*lines 18-24 of column 9: "A scene, or portions of a scene, can be divided into pixel regions (32×32 pixels in one specific implementation), called chunks. In one implementation, the system divides the geometry assigned to gsprites into chunks, but an alternative implementation could perform chunking without gsprites. The geometry is presorted into bins based on which chunk the geometry will be rendered into."*) generating rendering data having depth information on a pixel by pixel basis (*lines 37-41 of column 67: "...and Z is the Z-value which represents the depth of the pixel from the eye point, M is a 4×4 pixel coverage bitmask for each pixel which is partially covered..."*), and consolidating the rendering data of the three dimensional object in each of the subspaces by evaluating a distance in depth direction on a pixel by pixel basis" (*lines 12-16 of column 66: "To perform hidden surface removal, the pixel engine 406 compares depth values for incoming pixels (fully covered pixels or pixel fragments) with pixels at corresponding locations in the pixel or fragment buffers"*).

55. At the time of the invention, it would have been obvious to a person of ordinary skill in the art to use the per-pixel depth calculations of Myhrvold et al in Foran. The motivation for doing so would have been to accurately determine visible surfaces, as suggested in Myhrvold et

al in lines 37-41 of column 67. Therefore, it would have been obvious to combine Myhrvold et al with Foran to obtain the invention specified in claim 19.

56. With regard to claim 33, Foran discloses "an image processing apparatus comprising:

j. a grouping unit which groups input three-dimensional objects into groups (*paragraph [0040]: "First, the dimensions of the scene are bounded by a rectangular volume as shown in FIG. 2. Next, this volume is decomposed into rectangular subvolumes as shown in FIG. 3 such that each subvolume includes a portion of the overall scene... The position of each vertex is compared with the positions of the planar sides of the subvolumes to determine the subvolume to which the graphics primitive should be assigned."*);

k. a rendering processing unit which derives a subspace which contains at least one three-dimensional object belonging to the same group to be an independent rendering unit and performs rendering processing individually on the subspace, and generates independent image data (*paragraph [0044]: "In FIG. 5, at a step 506, the viewing position is communicated to each GPU. At a step 508, each GPU renders the graphics data that has been allocated to it."*);

l. a consolidation unit which generates final output image data to be displayed by consolidating image data generated for each subspace (*paragraph [0045]: "At a step 512, the outputs of the individuals GPUs are combined by blending."; Figure 7*).

57. Foran discloses, "image blending accounts for the spatial relationships between the viewing position and the rendered images so that objects that are more near the viewing position overwrite those that are more distant" (*paragraph [0045]*). Foran does not expressly disclose the

image data has "per-pixel Z values indicating depth information on a pixel by pixel basis for each subspace" or consolidating image data "having per-pixel z-values."

58. With regard to claim 33, Myhrvold et al discloses "an image processing apparatus comprising: generating independent image data having per-pixel Z values indicating depth information on a pixel by pixel basis for each subspace (*lines 37-41 of column 67: "...and Z is the Z-value which represents the depth of the pixel from the eye point, M is a 4×4 pixel coverage bitmask for each pixel which is partially covered..."*); and image data having per-pixel Z values generated for a subspace (*lines 12-16 of column 66: "To perform hidden surface removal, the pixel engine 406 compares depth values for incoming pixels (fully covered pixels or pixel fragments) with pixels at corresponding locations in the pixel or fragment buffers"*).

59. At the time of the invention, it would have been obvious to a person of ordinary skill in the art to use the per-pixel depth image data of Myhrvold et al in Foran. The motivation for doing so would have been to accurately determine visible surfaces, as suggested in Myhrvold et al in lines 37-41 of column 67. Therefore, it would have been obvious to combine Myhrvold et al with Foran to obtain the invention specified in claim 33.

Response to Arguments

60. Applicant's arguments with respect to all previously presented claims have been considered but are moot in view of the new ground(s) of rejection necessitated by Applicant's amendment.

Allowable Subject Matter

61. Claims 7, 31, 32 and 34 are rejected under 35 U.S.C. 112, first paragraph, for lack of enablement, but contain limitations not found in the prior art of record.

62. Claim 31 depends from claim 1, and recites the following limitation in combination with the limitations recited in the parent claim that is not found in the prior art: the grouping unit groups the intersecting three-dimensional objects, to each of which a different rendering strategy is applied, into the separate groups

63. With regard to claim 31, U.S. Patent No. 6,016,150 to Lengyel et al discloses grouping geometry and a different rendering strategy is applied to the separate groups (*lines 54-59 of column 10*). U.S. Patent Application Pub. No. 2002/0015055 to Foran discloses three-dimensional subspaces. However, one of ordinary skill in the art would not have included a grouping unit that groups the <u>intersecting</u> three-dimensional objects, to each of which a different rendering strategy is applied, into the separate groups, in combination with the limitations recited in claim 1 in Foran.

64. Claim 32 depends from claim 1, and recites the following limitation in combination with the limitations recited in the parent claim that is not found in the prior art: "the rendering processing unit generates the independent image data for each subspace, the independent image data having per-pixel Z values indicating depth information on a pixel by pixel basis; and the consolidation unit generates the final output image data to be displayed by performing Z-merge processing of the image data generated for each subspace according to the per-pixel Z values, when three-dimensional subspace, each of which contains at least one three-dimensional object belonging to the same group, are allowed to spatially overlap one another."

65. With regard to claims 32 and 7, U.S. Patent No. 5,867,166 to Myhrvold et al discloses "per-pixel Z values" (*lines 37-41 of column 67*) for determining visible surfaces to be rendered to an image. U.S. Patent Application Pub. No. 2002/0015055 to Foran discloses "an image

processing method comprising dividing a space into three-dimensional subspaces which are allowed to spatially overlap one another (*paragraph [0040]*). While it would have been obvious to a person of ordinary skill in the art to use the per-pixel depth image data of Myhrvold et al in Foran to accurately determine visible surfaces, it would not have been obvious to "the rendering processing unit generates the independent image data for each subspace, the independent image data having per-pixel Z values indicating depth information on a pixel by pixel basis; generates the final output image data to be displayed by performing Z-merge processing of the image data generated for each subspace according to the per-pixel Z values, when three-dimensional subspace, each of which contains at least one three-dimensional object belonging to the same group, are allowed to spatially overlap one another," as the spatial sub volumes disclosed in Foran are ordered according to depth from the viewpoint (paragraph [0045]). However, pixel by pixel z values could be used to resolve visibility within the sub-volumes taught by Foran, which is excluded by the claim language. Claim 7 depends from claim 32 and therefore contains subject matter not found in the prior art.

66. With regard to claim 34, U.S. Patent No. 5,867,166 to Myhrvold et al discloses "per-pixel Z values" (*lines 37-41 of column 67*) for determine visible surfaces to be rendered to an image. U.S. Patent Application Pub. No. 2002/0015055 to Foran discloses "an image processing method comprising dividing a space into three-dimensional subspaces which are allowed to spatially overlap one another (*paragraph [0040]*). In the parent claim 34, Foran shows "a consolidation unit which generates final output image data to be displayed by consolidating image data generated for each subspace (*paragraph [0045]: "At a step 512, the outputs of the individuals GPUs are combined by blending."; Figure 7*). Myhrvold et al discloses "an image processing

apparatus comprising: generating independent image data having per-pixel Z values indicating depth information on a pixel by pixel basis for each subspace (*lines 37-41 of column 67*); and image data having per-pixel Z values generated for a subspace (*lines 12-16 of column 66*). While it would have been obvious to a person of ordinary skill in the art to use the per-pixel depth image data of Myhrvold et al in Foran, it would not have been obvious to provide a "consolidation unit which generates the final output image data to be displayed by performing Z-merge processing of the image data generated for each subspace according to the per-pixel Z values, when three-dimensional subspaces, each of which contains at least one three-dimensional object belonging to the same group, are allowed to spatially overlap."

Conclusion

The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. U.S. Patent No. 5,757,385 Narayanaswami et al discloses a system of rendering using multiple processors.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Jason M. Repko whose telephone number is 571-272-8624. The examiner can normally be reached on Monday through Friday 8:30 am -5:00 pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Ulka Chauhan can be reached on 571-272-7782. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

JMR

ULKA CHAUHAN
SUPERVISORY PATENT EXAMINER